# PATENT COOPERATION TREATY

# PCT



## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

| | | |
|---|---|---|
| Applicant's or agent's file reference 16650.1110 | FOR FURTHER ACTION | See Form PCT/IPEA/416 |
| International application No. PCT/US04/34120 | International filing date *(day/month/year)* 15 October 2004 (15.10.2004) | Priority date *(day/month/year)* |
| International Patent Classification (IPC) or national classification and IPC<br>IPC(7): B01D 61/00, 61/14, 61/18, 61/12; C02C 1/36 and US Cl.: 210/651, 650, 653, 654, 638, 321.67, 321.68, 384 | | |
| Applicant<br>KERR-MCGEE CHEMICAL LLC | | |

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 12 sheets, as follows:
      ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s))
      _____ , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☒ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☐ Box No. VII Certain defects in the international application
   - ☐ Box No. VIII Certain observations on the international application

| | |
|---|---|
| Date of submission of the demand<br>06 April 2005 (06.04.2005) | Date of completion of this report<br>04 July 2005 (04.07.2005) |
| Name and mailing address of the IPEA/ US<br>Mail Stop PCT, Attn: IPEA/US<br>Commissioner for Patents<br>P.O. Box 1450<br>Alexandria, Virginia 22313-1450<br>Facsimile No. (703) 305-3230 | Authorized officer<br>Krishnan S. Menon<br>Telephone No. 571-272-1700<br>DEBORAH A. THOMAS<br>PARALEGAL SPECIALIST<br>~~GROUP 1300~~ |

Form PCT/IPEA/409 (cover sheet)(January 2004)

**Supplemental Box**

Re the filter-stack claims 63-65: the modification of the prior art, the complete circumferential welding of plate 22, is not patentable, since this modification is not making an unobvious structural change in the stack, such as a change in the flow pattern. Moreover, the Dominguez ref teaches a stack with the same flow pattern, and without the holes with tack-welded covers. Circumferential welding is only a process step, and is not a patentable structural limitation in an apparatus claim. The reference shows a diverter tray without any holes, which negates the need for the weld.

Claims 47-50, 52-56 and 61 lack an inventive step under PCT Article 33(3) as being obvious over Trendell'628 in view of Domniguez'848 and further in view of Moller' 605.

Trendell teaches concentration of titanium dioxide slurries by filtration through an oscillating or vibrating filter stack as claimed, including starting from very low (col 2 lines 7-12) to and final product concentration of 70-80 %, which conforms to the specific gravity of 2.2-2.3 (col 1 lines 43-53). Instead of feed and permeate pressures trans-membrane pressure drops are provided, which fall within the range claimed. Filtration rate, or increase in specific gravity per hr, is seen in col 4 lines 45-53. The permeate specific gravity of 1-1.1 is also met, since the specific gravity of 1 is pure water permeate. The operation times, such as permeate flow through stack (20 min to 16 hrs) depend on the capacity of the equipment and can be optimized. Process optimization for precise operation is taught in col 3 lines 1-20. Permeate recirculation, fresh water addition, fresh feed addition, withdrawal of the concentrate slurry, etc., as well as prevention of membrane blockage are contemplated in columns 3 and 4. Trendell does not teach the VSEP system, but Dominguez does. It would be obvious to one of ordinary skill in the art at the time of invention to use the teaching of Dominguez because Trendell does not teach any specific equipment for the process. The apparatus is capable of being monitored for the motor load, even if the references do not teach doing so, because the applicant uses the same apparatus. Converting the diverter tray to a filtering tray is also part of the process optimization depending on the feed slurry composition and flow rates; the apparatus is capable of it, and therefore, lacks inventive step. These instant claims further add a permeate flushing step, which is not explicitly taught by Trendell or Dominguez. However, flushing the apparatus to remove the build up of the thickened slurry from the membrane is an inherent process step when the Trendell teaches the trans membrane pressure drop limits. Using permeate to flush would be obvious to one of ordinary skill in the art because it is conventional to use the filtrate or the permeate to flush or back-flush the filters or membranes as taught by Moller (see col 11 lines 20-58).

Claims 1,3-6,11-21,23-26,30-41, 43-45, 47-50, 52-67 and 69-80 meet the criteria set out in PCT Article 33(4), and thus meet industrial applicability because the subject matter claimed can be made or used in paint and pigment industry.

**Supplemental Box**

**In case the space in any of the preceding boxes is not sufficient.**

Continuation of:

V.1. Reasoned Statements:
The opinion as to Novelty was positive (Yes)with respect to claims 1,3-6,11-21,23-26,30-41,43-45,47-50,52-67,69-80
The opinion as to Novelty was negative (No) with respect to claims NONE
The opinion as to Inventive Step was positive (Yes)with respect to claims 1,3-6,11-21,23-26,30-41 and 43-45
The opinion as to Inventive Step was negative(NO) with respect to claims 47-50,52-67,69-80
The opinion as to Industrial Applicability was positive (YES) with respect to claims 1,3-6,11-21,23-26,30-41,43-45,47-50,52-67,69-80
The opinion as to Industrial Applicability was negative(NO) with respect to claims NONE

**V. 2. Citations and Explanations:**
Claims 1,3-6,11-21,23-26,30-41 and 43-45 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest process steps for starting the process with low density slurry (diluted) or permeate to prevent blinding of the filter during start up, which is also shown to produce unexpected results - significantly extended filter life of the VSEP filter stack.

Claims 57-60, 62-67 and 69-80 lack an inventive step under PCT Article 33(3) as being obvious over Trendell'628 in view of Domniguez'848.

Trendell teaches concentration of titanium dioxide slurries by filtration through an oscillating or vibrating filter stack as claimed, including starting from very low (col 2 lines 7-12) to and final product concentration of 70-80 %, which conforms to the specific gravity of 2.2-2.3 (col 1 lines 43-53). Instead of feed and permeate pressures trans-membrane pressure drops are provided, which fall within the range claimed. Filtration rate, or increase in specific gravity per hr, is seen in col 4 lines 45-53. The permeate specific gravity of 1-1.1 is also met, since the specific gravity of 1 is pure water permeate. The operation times, such as permeate flow through stack (20 min to 16 hrs) depend on the capacity of the equipment and can be optimized. Process optimization for precise operation is taught in col 3 lines 1-20. Permeate recirculation, fresh water addition, fresh feed addition, withdrawal of the concentrate slurry, etc., as well as prevention of membrane blockage are contemplated in columns 3 and 4. Loading the concentrate to another tank for transportation as in claim 66 is an obvious step within the skill level of one of ordinary skill.

Trendell does not teach the VSEP system, but Dominguez does. It would be obvious to one of ordinary skill in the art at the time of invention to use the teaching of Dominguez because Trendell does not teach any specific equipment for the process. The apparatus is capable of being monitored for the motor load, even if the references do not teach doing so, because the applicant uses the same apparatus. Converting the diverter tray to a filtering tray is also part of the process optimization depending on the feed slurry composition and flow rates; the apparatus is capable of it, and therefore, lacks inventive step. Regarding the modification of the diverter trays as in claim 72, the VSEP system as in Dominguez does not have a port with a tack-welded cover and therefore does not require a complete weld. In any case, the welding of cover 22 on diverter tray 14 does not contribute to a change in the instant process when compared to a diverter tray with just the tack-welds as in the original apparatus as disclosed in the applicant's specification. Overall, the claims recite detailed process steps but lack inventive steps.

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/US04/34120

**Box No. I Basis of the report**

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on translations from the original language into the following language _____, which is the language of a translation furnished for the purposes of:

☐ international search (under Rules 12.3 and 23.1(b))

☐ publication of the international application (under Rule 12.4)

☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

☐ the international application as originally filed/furnished

☒ the description:
pages 2-17 as originally filed/furnished
pages* 1 received by this Authority on 06 April 2005 (06.04.2005)
pages* NONE received by this Authority on _____

☒ the claims:
pages NONE as originally filed/furnished
pages* NONE as amended (together with any statement) under Article 19
pages* 18-28 received by this Authority on 06 April 2005 (06.04.2005)
pages* NONE received by this Authority on _____

☒ the drawings:
pages 1-4 as originally filed/furnished
pages* NONE received by this Authority on _____
pages* NONE received by this Authority on _____

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☒ The amendments have resulted in the cancellation of:

☐ the description, pages _____
☒ the claims, Nos. 2,7-10,22,27-29,42,46,51,68
☐ the drawings, sheets/figs _____
☐ the sequence listing (*specify*): _____
☐ any table(s) related to the sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/figs _____
☐ the sequence listing (*specify*): _____
☐ any table(s) related to the sequence listing (*specify*): _____

** If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/US04/34120

**Box No. IV Lack of unity of invention**

1. ☒ In response to the invitation to restrict or pay additional fees the applicant has:

   ☐ restricted the claims.

   ☒ paid additional fees.

   ☐ paid additional fees under protest.

   ☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is:

   ☐ complied with.

   ☒ not complied with for the following reasons:

See the lack of unity section of the International Search Report(Form PCT/ISA/210)

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☒ all parts

   ☐ the parts relating to claims Nos. ____

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/US04/34120

**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

| | | |
|---|---|---|
| Novelty (N) | Claims Please See Continuation Sheet | YES |
| | Claims Please See Continuation Sheet | NO |
| Inventive Step (IS) | Claims Please See Continuation Sheet | YES |
| | Claims Please See Continuation Sheet | NO |
| Industrial Applicability (IA) | Claims Please See Continuation Sheet | YES |
| | Claims Please See Continuation Sheet | NO |

2. Citations and Explanations (Rule 70.7)
Please See Continuation Sheet

# IMPROVED METHOD AND APPARATUS FOR CONCENTRATING A SLURRY

## Background of the Invention

[0001] Manufacture of pigment grade titanium dioxide requires several processing steps. Generation of a raw or crude titanium dioxide pigment, via calcination in a sulfate process or oxidation in a chloride process, is an intermediate step in the pigment manufacturing process. The raw pigment is then isolated from undesirable salts and conventionally milled as a slurry with various surface treatments to yield a pigment having a desired particle size distribution. Further, certain manufacturing processes benefit from the use of a slurry of a finished titanium dioxide. However, the slurry generated during the manufacturing process contains an excess of water leading to increased shipping costs. Therefore, methods for dewatering titanium dioxide slurries have been developed.

[0002] One currently available system for dewatering slurries is the VSEP Filtration System available from New Logic Research Inc. (V◇SEP is a registered trademark of New Logic Research, Inc.). The VSEP process utilizes a filtration system (the "VSEP filtration system") containing a filter stack consisting of a series of disks or trays and diverters. Each filter disk has outer membranes with pore sizes generally no larger than 0.1μ and normally a drain cloth positioned between the outer membranes and the disk. The diverters determine the flow pattern through the filter stack. A typical VSEP filtration system is schematically depicted in Fig. 1 and a typical filter stack is depicted in Fig. 2. VSEP filtration systems are explained in greater detail, for example, in United States Patents No. 4,872,988 and 4,952,317, incorporated herein by reference.

[0003] The VSEP filtration system concentrates the slurry of titanium dioxide by removing water from the slurry as it passes over the filter disks and diverters. As the specific gravity of the slurry of titanium dioxide increases, particle build up on the filter disks and diverters will occur unless the shear rate at the membrane surface is sufficient to remove the particles. To generate the necessary shear rate, the VSEP filtration system typically oscillates the trays at an amplitude of movement of about 1.9 cm (0.75 inches). This oscillation produces a shear rate at the membrane-liquid interface of about 150,000 inverse seconds. The VSEP system produces a clear water stream, referred to as permeate, and a slurry of titanium dioxide, referred to as a concentrate.

[0004] When performing within the manufacturer's specification, a standard high solids VSEP filter stack lasts between 1 and 45 days and has an average life span of 18 days.

We claim:

1. A method for dewatering a slurry of titanium dioxide having an initial specific gravity of from about 1.2 to about 1.8 using a filtration system comprising a filter stack, a means for oscillating said filter stack, a feed tank, a permeate holding tank, a concentrate removal line and a water source, said filter stack comprising filter disks and diverter trays, wherein the method comprises the steps of:

initially removing a sufficient quantity of said slurry having a specific gravity of from about 1.2 to about 1.8 from said feed tank such that addition of water or permeate to the remaining slurry in said feed tank will yield a slurry having a specific gravity ranging from about 1.01 to about 1.1;

passing permeate fluid from said permeate holding tank through said filter stack for period of time ranging from about 20 minutes to about 16 hours;

initiating fluid flow from said feed tank while directing concentrate flow from said filter stack to said feed tank;

increasing the specific gravity of the slurry in said feed tank at a rate of about 0.1 per hour to a range of about 1.4 to about 1.8, wherein following the increase in specific gravity of said slurry entering said filter stack, said concentrate removed from said filter stack has a specific gravity ranging from about 2.0 to about 2.3 and said permeate removed from said filter stack has a specific gravity ranging from about 1.0 to about 1.1;

adjusting fluid pressure of fluid entering said filter stack to a pressure between about 275 kPa and about 830 kPa;

initiating oscillation of said filter stack; and,

subsequently setting the oscillation amplitude of said filter stack to a distance between about 0.6 cm and about 3.8 cm.

2. [Cancelled]

3. The method of claim 1, wherein the slurry added to said feed tank has a specific gravity of from about 1.4 to about 1.53.

4. The method of claim 1, wherein said filter stack is initially oscillated at an amplitude between about 0.32 cm and about 1.3 cm.

5. The method of claim 4, wherein said filter stack is initially oscillated for a period of time ranging from about 30 to about 120 minutes at the first amplitude setting and is subsequently oscillated for a period of time of about 4 hours at a second amplitude setting.

6. The method of claim 4, wherein the final oscillation amplitude is maintained between about 1.9 cm and about 2.2 cm.

7. [Cancelled]

PCT/US04/34120
IPEA/US 06 Apr 2005

8. [Cancelled]

9. [Cancelled]

10. [Cancelled]

11. The method of claim 1, wherein the permeate fluid passes through said filter stack for a period of time ranging from about 1 to about 2 hours.

12. The method of claim 1, wherein the permeate fluid stream exits the filter stack at a fluid pressure of about 34 kPa to about 172 kPa.

13. The method of claim 1, wherein the permeate fluid stream exits the filter stack at a fluid pressure of about 82 kPa to about 110 kPa.

14. The method of claim 1, further comprising the steps of:

monitoring concentrate flow rate and specific gravity;

stopping the flow of slurry from said feed tank following detection of a concentrate specific gravity of greater than about 2.3 when processing a slurry containing the anatase form of titanium dioxide and greater than 2.2 when processing a slurry containing the rutile form of titanium dioxide;

flushing said filter stack;

restoring slurry flow from said feed tank; and,

continuing to monitor concentrate flow rate and specific gravity.

15. The method of claim 14, wherein said step of flushing said filter stack is achieved by replacing the slurry flow from said feed tank with permeate flow obtained from said permeate holding tank.

16. The method of claim 14, wherein said filter stack is flushed for a period of time of at least 100 seconds.

17. The method of claim 14, wherein said filter stack is flushed for a period of time of at least 200 seconds.

18. The method of claim 14, wherein said filter stack is flushed for a period of time of at least 300 seconds.

19. The method of claim 14, wherein the step of flushing takes place for a period of time sufficient to lower the concentrate specific gravity to a range of about 1.0 to about 1.2.

20. A method for dewatering a slurry of titanium dioxide having an initial specific gravity of about 1.01 or greater using a filtration system comprising a filter stack, a means for oscillating said filter stack, a feed tank, a permeate holding tank, a concentrate removal line and a water source wherein the method comprises the steps of:

removing slurry from said feed tank;

when said slurry in said feed tank initially has a specific gravity of about 1.2 or greater, adding sufficient water or permeate to said feed tank to reduce the specific gravity of the slurry stored in said feed tank to a range of about 1.01 to about 1.1;

passing permeate fluid from said permeate holding tank through said filter stack for period of time ranging from about 20 minutes to about 16 hours;

initiating fluid flow from said feed tank while directing concentrate flow from said filter stack to said feed tank;

adding slurry to said feed tank thereby increasing the specific gravity of the slurry in said feed tank to a range of about 1.2 to about 1.8 whereby the rate of increase of the specific gravity of the slurry in said feed tank is about 0.1 per hour;

initiating oscillation of said filter stack;

increasing the oscillation amplitude of said filter stack;

setting the oscillation amplitude of said filter stack to a distance between about 0.6 cm and about 3.8 cm;

increasing the specific gravity of the slurry in said feed tank; and,

removing concentrate and permeate from said filter stack, said concentrate removed from said filter stack has a specific gravity ranging from about 2.0 to about 2.3 and said permeate removed from said filter stack has a specific gravity ranging from about 1.0 to about 1.

21. The method of claim 20, further comprising the steps of:

monitoring concentrate flow rate and specific gravity;

stopping the flow of slurry from said feed tank following detection of a concentrate specific gravity of greater than about 2.3 when processing a slurry containing the anatase form of titanium dioxide and greater than about 2.2 when processing a slurry containing the rutile form of titanium dioxide;

flushing said filter stack; and,

restoring slurry flow from said feed tank while continuing to monitor concentrate flow rate and specific gravity.

22. [Cancelled]

23. The method of claim 20, wherein the slurry added to said feed tank has a specific gravity of from about 1.4 to about 1.53.

24. The method of claim 20, wherein said filter stack is initially oscillated at an amplitude between about 0.32 cm and about 1.3 cm.

25. The method of claim 24, wherein said filter stack is initially oscillated for a period of time ranging from about 30 to about 120 minutes at the first amplitude setting and is subsequently oscillated for a period of time of about 4 hours at a second amplitude setting.

26. The method of claim 24, wherein the final amplitude is between about 1.9 cm and about 2.2 cm.

27. [Cancelled]

28. [Cancalled]

29. [Cancelled]

30. The method of claim 20, wherein the permeate fluid passes through said filter stack for a period of time ranging from about 1 to about 2 hours.

31. The method of claim 21, wherein said step of flushing said filter stack is achieved by replacing the slurry flow from said feed tank with permeate flow obtained from said permeate holding tank.

32. The method of claim 21, wherein the step of flushing said filter stack takes place for a period of time of at least 100 seconds.

33. The method of claim 21, wherein the step of flushing said filter stack takes place for a period of time of at least 200 seconds.

34. The method of claim 21, wherein the step of flushing said filter stack takes place for a period of time of at least 300 seconds.

35. The method of claim 21, wherein the step of flushing said filter stack takes place for a period of time sufficient to lower the concentrate specific gravity to a range of about 1.0 to about 1.2.

36. A method for dewatering a slurry of titanium dioxide having an initial specific gravity of from about 1.01 to about 1.8 using a filtration system comprising a filter stack, a means for oscillating said filter stack, a feed tank containing a slurry, a permeate holding tank, a concentrate removal line and a water source wherein the method comprises the steps of:

when said slurry in said feed tank initially has a specific gravity of about 1.2 or greater, lowering the specific gravity of said slurry stored in said feed tank to a range of about 1.0 to about 1.1;

passing permeate fluid from said permeate holding tank through said filter stack for period of time ranging from about 20 minutes to about 16 hours, said permeate fluid having a specific gravity between about 1.0 and about 1.1;

initiating fluid flow from said feed tank while directing concentrate flow from said filter stack to said feed tank;

adding slurry having a specific gravity of from about 1.2 to about 1.8 to said feed tank;

initiating oscillation of said filter stack at an amplitude between about 0.32 cm and about 0.6 cm;

increasing oscillation of said filter stack to an amplitude between about 0.6 cm and about 1.3 cm;

subsequently setting the oscillation of said filter stack to an amplitude between about 0.6 cm and about 3.8 cm;

increasing the specific gravity of the slurry in said feed tank to a range of about 1.2 to about 1.8;

removing concentrate and permeate from said filter stack, said concentrating having a specific gravity ranging from about 2.0 to about 2.2 when processing a slurry containing the rutile form of titanium dioxide, said concentrate having a specific gravity ranging from about 2.0 to about 2.3 when processing a slurry containing the anatase form of titanium dioxide and said permeate having a specific gravity ranging from about 1.0 to about 1.1;

monitoring concentrate flow rate and specific gravity;

flushing said filter stack by replacing the slurry flow from said feed tank with permeate flow obtained from said permeate holding tank for a period of time sufficient to lower the concentrate specific gravity to a range of about 1.0 to about 1.2 upon detection of a concentrate specific gravity of greater than 2.2 when processing a slurry containing the rutile form of titanium dioxide and greater than 2.3 when processing a slurry containing the anatase form of titanium dioxide; and,

restoring slurry flow from said feed tank while continuing to monitor concentrate flow rate and specific gravity.

37. The method of claim 36, wherein the permeate fluid passes through said filter stack for a period of time ranging from about 1 to about 2 hours.

38. The method of claim 36, wherein said filter stack is initially oscillated at an amplitude of about 0.32 cm to about 0.6 cm for about 30 to about 120 minutes.

39. The method of claim 36, wherein the step of oscillating said filter stack at an amplitude between about 0.6 cm and about 1.3 cm is maintained for about 4 hours.

40. The method of claim 36, wherein the final oscillation amplitude is maintained between about 1.9 cm and about 2.2 cm.

41. The method of claim 36, wherein the step of increasing the specific gravity of the slurry in said feed tank to a range of about 1.1 to about 1.8 occurs over a period of time at a rate of increase of about 0.10 per hour.

42. [Cancelled]

43. The method of claim 36, wherein the step of flushing lasts for a period of time of at least 100 seconds.

44. The method of claim 36, wherein the step of flushing lasts for a period of time of at least 200 seconds.

45. The method of claim 36, wherein the step of flushing lasts for a period of time of at least 300 seconds.

46. [Cancelled]

47. A method for dewatering a slurry of titanium dioxide using a VSEP filtration system comprising a filter stack, a motor and a concentrate fluid line comprising the steps of:

monitoring concentrate flow rate, concentrate fluid pressure, concentrate specific gravity in said concentrate line;

monitoring motor load;

stopping the flow of said slurry of titanium dioxide to said filter stack following detection of an out of range value for concentrate flow rate, concentrate fluid pressure, concentrate specific gravity or motor load;

flushing said filter stack until the specific gravity of the concentrate exiting the filter stack has been reduced to a range of about 1.0 to about 1.2 by replacing said slurry of titanium dioxide flowing to said filter stack with permeate obtained from a permeate holding tank; and,

restoring flow of said slurry of titanium dioxide to said filter stack.

48. The method of claim 47, wherein the step of flushing the filter stack continues for about 100 seconds.

49. The method of claim 47, wherein the step of flushing the filter stack continues for about 200 seconds.

50. The method of claim 47, wherein the step of flushing the filter stack continues for about 300 seconds.

51. [Cancelled]

52. The method of claim 47, wherein said step of flushing said filter stack passes water or permeate fluid through the concentrate out port of said filter stack.

53. The method of claim 47, wherein said filter stack comprises a series of filter disks and diverter trays and further includes the step of converting a portion of said diverter trays to filter disks.

54. The method of claim 47, further comprising the steps of determining the transmembrane pressure;

stopping flow of said slurry to said filter stack when a transmembrane pressure of less than about 207 kPa is detected; and,

flushing said filter stack.

55. The method of claim 47, further comprising the step of monitoring permeate fluid pressure;.

stopping flow of said slurry to said filter stack when a permeate fluid pressure of greater than 124 kPa is detected; and,

flushing said filter stack.

56. The method of claim 47, further comprising the steps of:

monitoring fluid pressure of said slurry entering said filter stack;

stopping flow of said slurry when a fluid pressure of about 827 kPa is detected; and,

flushing said filter stack.

57. A method for dewatering a slurry of titanium dioxide using a VSEP filtration system comprising a motor, a concentrate fluid line and a filter stack, said filter stack comprising a series of filter disks and diverter trays, comprising the steps of:

monitoring concentrate flow rate, concentrate fluid pressure, concentrate specific gravity in said concentrate line;

monitoring motor load;

stopping the flow of said slurry of titanium dioxide to said filter stack following detection of an out of range concentrate flow rate, concentrate fluid pressure, concentrate specific gravity or motor load;

converting a portion of said diverter trays to filter disks; and,

restoring flow of said slurry of titanium dioxide to said filter stack.

58. The method of claim 57, wherein about 30% of said diverter trays are converted to filter disks by drilling out diverter plates welded to said diverter trays.

59. The method of claim 57, further comprising the step of flushing said filter stack prior to converting said diverter trays to filter disks.

60. The method of claim 57, further comprising the steps of determining the transmembrane pressure;

stopping flow of said slurry to said filter stack when a transmembrane pressure of less than about 207 kPa is detected; and,

flushing said filter stack prior to converting a portion of said diverter trays to filter disks.

61. The method of claim 57, further comprising the step of monitoring permeate fluid pressure;

stopping flow of said slurry to said filter stack when a permeate fluid pressure of greater than 124 kPa is detected; and,

flushing said filter stack prior to converting a portion of said diverter trays to filter disks.

62. The method of claim 57, further comprising the steps of:

monitoring fluid pressure of said slurry entering said filter stack;

stopping flow of said slurry when a fluid pressure of about 827 kPa is detected; and,

flushing said filter stack prior to converting a portion of said diverter trays to filter disks.

63. A filter stack comprising at least two filter disks and at least one diverter tray, said filter disks and diverter tray being arranged in parallel one above the other, each filter disk and each diverter tray comprises a filter membrane support having at least two ports located a distance from the center of said membrane support, at least one layer of filter membrane, and a central permeate passageway, wherein the improvement comprises:

a diverter plate welded over one of the two ports located a distance from the center of said membrane support of said diverter tray thereby substantially blocking fluid flow through said port; and,

said weld attaching said diverter plate over said slurry feed port is a substantially complete weld around the circumference of said diverter plate.

64. The filter stack of claim 63, wherein said diverter plate completely blocks fluid flow through said port.

65. The filter stack of claim 63, wherein said weld attaching said diverter plate over said port is a continuous bead weld around the complete circumference of said diverter plate.

66. A method for preparing and transporting a slurry of titanium dioxide comprising the steps of:

providing a slurry of titanium dioxide having a specific gravity between about 1.1 and about 1.8;

dewatering said slurry of titanium dioxide to yield a concentrate having a specific gravity of about 2.0 to about 2.3 and a permeate having a specific gravity between about 1.0 and about 1.1;

passing said permeate to a permeate holding tank;

passing said concentrate to a concentrate holding tank while directing any concentrate having a specific gravity less than about 2.0 back to said filter stack and further dewatering said concentrate;

loading said concentrate from said concentrate holding tank into a transportation tank; and,

transporting said concentrate to a finishing plant.

67. The method of claim 66, further comprising the steps of:

monitoring the fluid pressure of said slurry of titanium dioxide to be dewatered;

passing said slurry of titanium dioxide into a filter stack comprising a series of filter disks and diverter trays;

removing said permeate from said filter stack through a first port and removing said concentrate through a second port;

monitoring the fluid pressure of said permeate and said concentrate; and,

monitoring the specific gravity of said concentrate.

68. [Cancelled]

PCT/US04/34120
IPEA/US 06Apr05

69. The method of claim 66, wherein said concentrate has a specific gravity between about 2.0 and about 2.3 when said slurry to be dewatered contains the anatase form of titanium dioxide and between about 2.0 and about 2.2 when said slurry to be dewatered contains the rutile form of titanium dioxide.

70. The method of claim 66, wherein said concentrate has a specific gravity of about 2.18.

71. The method of claim 66, wherein said slurry to be dewatered has an initial specific gravity between about 1.4 and about 1.53.

72. The method of claim 66, wherein said filter stack comprises:

at least two filter disks and at least one diverter tray, said filter disks and diverter tray being arranged in parallel one above the other each filter disk, each diverter tray comprises a filter membrane support having at least two ports located a distance from the center of said membrane support, at least one layer of filter membrane, and a central permeate passageway;

a diverter plate welded over one of the two ports located a distance from the center of said membrane support of said diverter tray thereby substantially blocking fluid flow through said port; and,

said weld attaching said diverter plate over said slurry feed port is a substantially complete weld around the circumference of said diverter plate.

73. The method of claim 72, wherein said diverter plate completely blocks fluid flow through said port.

74. The method of claim 72, wherein said filter stack comprises at least 100 filter disks having at least two ports located a distance from the center of said membrane support and at least 10 filter disks having a diverter plate welded over one of said ports wherein said weld attaching said diverter plate over said port is a continuous bead weld around the complete circumference of said diverter plate.

75. The method of claim 72, wherein said weld attaching said diverter plate over said port is a continuous bead weld around the complete circumference of said diverter plate.

76. The method of claim 66, further comprising the step of conditioning said filter stack by passing permeate from said permeate holding tank through said filter stack for period of time ranging from about 20 minutes to about 16 hours, said permeate having a specific gravity between about 1.0 and about 1.1.

77. The method of claim 76, wherein said permeate passes through said filter stack for a period of time ranging from about 1 to about 2 hours.

78. The method of claim 76, further comprising the steps of:

initially oscillating said filter stack at an amplitude of about 0.32 cm to about 0.6 cm for about 30 to about 120 minutes while passing said permeate through said filter stack;

increasing the oscillation amplitude to between about 0.6 cm and about 1.3 cm and maintaining said amplitude for about 4 hours;

finally setting the oscillation amplitude between about 1.9 cm and about 2.2 cm.

79. The method of claim 78, wherein the specific gravity of fluid passing through said filter stack is increased from an initial specific gravity in the range of about 1.0 to about 1.1 to a final specific gravity in the range of about 1.1 to about 1.8 by increasing the specific gravity of the fluid passing through said filter at a rate of 0.1 per hour.

80. The method of claim 66, further comprising the steps of:

stopping flow of said slurry to be dewatered and flushing said filter stack upon detection of a concentrate specific gravity of greater than 2.2 when processing a slurry containing the rutile form of titanium dioxide and greater than 2.3 when processing a slurry containing the anatase form of titanium dioxide; and,

restoring slurry flow from said feed tank while continuing to monitor concentrate flow rate and specific gravity.